# MY STREET IS A RIVER:
## AN URBAN WATERSHED MODEL

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"This is one of the most difficult and most fun lessons to present. It is always a favorite with teachers as they know that their students will get the point… and it's messy" – Pauline Langsdorf, Metropolitan Council

**SUBJECTS:**
-Science, Social Studies, Language Arts
**LEVEL:**
-Grades 6 through 9
**TIME:**
-1-2 class periods, depending upon amount of pre-construction
**MATERIALS:**
-2' x 3' plastic rectangular box with lid
-plastic hose/tubing (5/8 inch diameter)
-9/16 inch fly-bit and electric drill (adults only)
-Styrofoam pieces (different sizes and thicknesses)
-Charcoal water filter (e.g. *Britta* filter, to be opened with a saw cut)
-food colorings
-nursery tree-bark wrap
-1' x 1' square of black nylon raincoat fabric (or other water-proof material)
-tree branch cuttings, or plastic foliage
-ground-up Styrofoam bits
-grass clippings
-foam plastic pipe insulation (split lengthwise for the street gutters)
-potting soil
- (optional) powdered potter's clay.
-tablespoon
-9 small glass jars
-scissors and knife
-plumber's putty
-toy cars
-watering can (or other sprinkling device)
-water
-paper towels (or newspaper)
-picture of different parking lots and urban areas
-2 transparent plastic (1-2 gallon size) jugs

# OBJECTIVES

The student will do the following:

1. Assist the teacher, as appropriate, in developing a model which demonstrates how non-permeable areas collect a number of pollutants which can runoff into nearby lakes and streams.
2. Cite examples of urban water pollution sources by observing the model.
3. Suggest ways to reduce runoff in urban areas by redesigning and testing the model.

# BACKGROUND INFORMATION

Rainwater running off roofs, lawns, streets, and parking lots can wash a number of water pollutants into lakes and streams. These pollutants include nutrients from garden fertilizers, bacteria from pet waste and rotting litter, sediments from erosion, toxic chemicals such as pesticides, oil, gasoline, and trace metals from emissions and grinding car parts (lead, mercury, and cadmium), zinc from roofs and gutters, and road salt or sand.

In developed areas, these pollutants usually collect on hard-surfaced parking lots and streets where they remain until a heavy rain washes them into nearby storm sewers. Sometimes these pollutants collect in such high concentrations that they kill fish when they are washed all at once into a steam. This is called "shock-loading". To prevent this from happening, urban planners are now planting grass filter strips, diversion ditches, and holding ponds to collect the runoff and allow it to seep slowly into the ground and/or to slow down the water so that less enters into storm sewers or washes into water bodies. A grass filter strip is an area of land planted with grass where water can flow instead of running directly into a storm drain. A diversion ditch is a channel lined with grass or riprap used to divert water away from an area. Diversion ditches divert water to open land or ponds where it can collect and be slowly absorbed into the ground.

# APPLICATION

When you use this model you will get a great volume of dirty "storm-water" filling one of the two jugs in the model. The jug collecting ground-water will have much less flow or "shock-loading" and the water will be much cleaner. Even before the water is applied to your model, you will get some of the pollutants flowing into the storm-water container. This also simulates real-life sewer pollution. The conditions in this model illustrate urban storm-water systems in a way understandable to audiences of all ages.
Some studies have calculated that a landscape that is 15% impermeable, or paved over, will begin to show a significant

degrading of water quality. Most urban surfaces are closer to 70-80% paved/impermeable. You may want to discuss ways to solve the watershed problems you have observed. Consider collecting and showing color pictures of how these problems may have affected your own communities. Talk about the value of storm-drain stenciling, "Don't Pollute - Drains to River", "Drains to Lakes", etc.

# ADVANCED PREPARATION

(NOTE: After checking my own home for the necessary supplies, it took me two hours of shopping to get the rest. I spent $30-40.00 to assemble the missing items. If a group pooled their efforts, this could perhaps be reduced. Assembly time is approximately two hours.)

I. Prepare the following mixtures in small glass jars and label as follows:
   a. ¼ cup (65 ml) water + 2 to 3 drops yellow food coloring + 2 to 3 drops green food coloring – label it "oil or gasoline".
   b. ½ cup (125 ml) water + 3 to 5 drops red food coloring – label it "trace metals".
   c. ½ cup (125 ml) water + 3 to 5 drops green food coloring – label it "fertilizers"
   d. ½ cup (125 ml) water + 3 to 5 drops yellow food coloring – label it "pet wastes and rotting litter."
   e. ½ cup (125 ml) water + potting soil – shake vigorously – label it "erosion". A nice alternative is to add powdered (or dissolved) potters clay. It has the advantage of not fermenting over time.
   f. ½ cup (125 ml) water + 5 drops blue food coloring – label it "toxic chemicals".
   g. ½ cup dry grass clippings (grind in a blender so they are small enough not to clog your model) – label it "grass clippings".
   h. 1/8 cup Styrofoam bits (Grind in blender NOTE: static cling may become a problem, add some water to prevent this) – label "Styrofoam bits".
   i. 1 tablespoon detergent in ½ cup water – label it "soap and detergent".

**NOTE:** If you decide to save the jars of "pollutants" for later use, remove the one with potting soil. In storage this one will create a putrefied mess. Make sure tub is thoroughly dried before storing with plastic cover.

# PROCEDURE

I. Setting the stage.
   a. Explain that rainwater running of roofs, lawns, streets, industrial sites, and other non-permeable areas washes a number of pollutants into lakes and streams.

   b. Tell the students that hard-surfaced parking lots provide no place for rain to slowly filter through the soil, and pollutants transported in urban storm-sewer systems include nutrients, bacteria, litter, soil, toxic chemicals, organic materials and rubbish.

II. Building the model
   a. Drill two holes on the <u>bottom</u> of the plastic box as illustrated. Insert a hose in each hole to serve as a drain. *The plastic tubing should be one size larger than the fly-bit used to drill the holes into the bottom of the tub.*

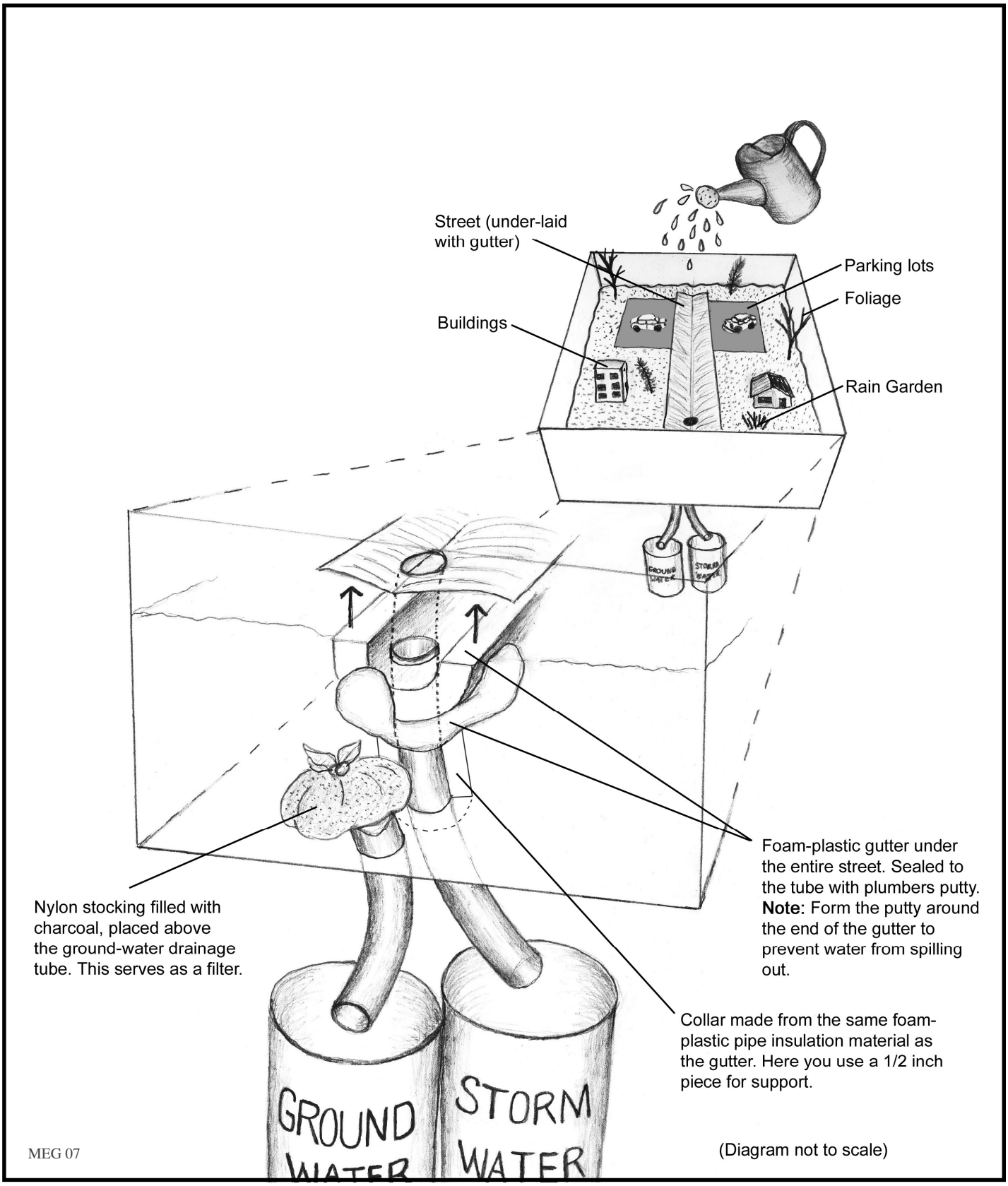
      - Before inserting the tubing, warm it up in a cup of boiling-hot water. It will then be flexible enough to force into the slightly undersized hole, making a leak-proof seal for the two drains; one leading to "street level" (storm-water) and the other draining to the very bottom of the tub (ground water).

   b. Place a nylon stocking filled with the charcoal contents of a water filter (e.g. Britta) over the "ground water" tube. This will simulate the filtration of the soil. (To get the charcoal out of the filter, carefully use a handsaw to crack open the filter).

   c. Use plumber's putty to seal the hose to the foam-plastic trough under the streets. This represents a city storm sewer. Explain to the students that water flowing through the hose will travel directly to nearby streams or lakes.

   d. Fill the tub 1/3 full with potting soil.

   **e.** The trough (or gutter) is to be placed under a street in the center of the tub, as illustrated. The trough is made from foam-plastic pipe insulation split length-wise, as illustrated, and should be placed about ½ inch above the bottom of the tub. It should be supported at the ½ inch level by a collar made of the foam-plastic, sealed with plumbers putty. The trough should be placed slightly below the top of the soil, so that surface water will collect in it, primarily water flowing UNDER the street. This is so it will form a natural street-drainage pattern when the tub is filled with potting soil. **Be sure that the trough is angled properly to receive virtually all of the "storm-water" which falls on the impermeable portions of the model.**


Street (under-laid with gutter)
Parking lots
Foliage
Buildings
Rain Garden
GROUND WATER
STORM WATER
Nylon stocking filled with charcoal, placed above the ground-water drainage tube. This serves as a filter.
Foam-plastic gutter under the entire street. Sealed to the tube with plumbers putty. **Note:** Form the putty around the end of the gutter to prevent water from spilling out.
Collar made from the same foam-plastic pipe insulation material as the gutter. Here you use a 1/2 inch piece for support.
MEG 07
(Diagram not to scale)

III. Urban landscape design and construction

a. Instruct the students to design their own urban environment by sketching a footprint of a road, parking lot, and buildings on a piece of paper.

b. Instruct the students to use Styrofoam or wooden blocks to represent buildings. Use raincoat material to lay out parking lots. The streets are made of nursery-tree wrap, folded length-wise, forming a slight "V"-shaped "paved" street. At one end of the "street", cut a circular hole to allow drainage to the "storm sewer" tube below it. Landscape the "non-paved" areas with plantings made from chopped foliage and twigs.

c. Once the students have competed the design, arrange a few *Matchbox* toy cars for a touch of realism.

IV. Bringing the model to "life"

**a.** When the students finish designing the urban area, instruct them to use tablespoons to deposit pollutants into the landscape. Use the pollutants prepared in the advanced-preparation section. The pollutants should be placed where they would occur normally. **Prop up the end opposite the drains in order to have the runoff drain towards the storm sewer and groundwater runoff drains.**

b. Place a large plastic jug under each hose to catch water coming out of the drains. Be sure to label the jugs "storm-water" and "ground-water". The tubes should hang over the edge of the table covered with newspaper or a towel. The receiving jugs should be placed on boxes high enough so that the tube actually enters the jug.

c. Create a heavy rainstorm using a sprinkling-type watering can. Keep raining until the pollutants wash off. Watch the water draining out of the storm drain. What does it look like? How did the runoff vary as you altered various elements of your model? Discuss why the "ground-water" drainage is so much cleaner than the "storm-water" drainage.

V. Follow-Up

a. How could the model be designed differently to reduce pollution? Discuss the important role of storm-water retention basins. What would happen if the water had not run off the model so quickly? What other things could be done to prevent urban pollution? Have the students redesign models with storm-water retention, rain gardens and less parking lot areas.

b. Compare the water collected from the storm-water jug to the sample from the ground-water jug. Discuss what was learned about keeping rivers and lakes cleaner, starting with the street in front of your house.

c. When the demonstration is complete, for easy transport, place the lid back on the tub and use duct tape to fasten a plastic bucket to the two drainage tubes. This will take care of the continued draining.

Credits: The world knows very few original ideas. The bulk of this watershed model design came from the Air & Waste Management Association, One Gateway Center, Third Floor, Pittsburgh, PA 15222. It was then modified by Pauline Langsdorf, Metropolitan Council Environmental Services, 230 E. 5th St., St. Paul MN 55101. It was further modified by Paul Nordell and Kelly Barthol at the Minnesota Department of Natural Resources, Adopt-a-River Program, 2/2/99. The last modification was done by Paul Nordell and Megan Godbold, Minnesota Department of Natural Resources, Adopt-a-River Program, 3/6/2007.